

X.—*On the Periods occupied by Birds in the Incubation of their Eggs.* By WILLIAM EVANS, F.R.S.E.

PROBABLY no point in the life-histories of the different species of birds has received less attention than the period of incubation, a circumstance all the more surprising when we consider the importance of the subject and the great activity which has been manifested during recent years in the elucidation of ornithological questions.

In the spring of 1887 I had occasion to seek information regarding the periods of incubation in the case of a number of our native birds, and was surprised to find how little that was reliable I was able to cull from the standard works on British ornithology. It then occurred to me that some useful experiments might readily be made by means of an incubator; and as a preliminary step in this direction I had a few eggs placed in a home-made machine belonging to a friend. The results, though disappointing as regards the number of eggs hatched, clearly foreshadowed a series of most interesting facts from experiments made under better conditions. Accordingly, at the commencement of the breeding-season of 1888, I purchased one of Hearson's self-regulating incubators, and kept it in operation as long as fresh eggs could be procured. It was again kept going during the season of 1889 and for a short time in 1890. Eggs of all sizes, from those of the Goldcrest to that of the Solan Goose, were experimented on. Taken all over, about 50 per cent. of them were hatched, the number of failures being greatest among the *Passeres* and least among the *Gallinæ*.

In the selection of eggs one must be guided greatly by experience and a knowledge of the nesting-habits of the different groups, as many birds commence to incubate before the full complement has been laid; but a good general rule is to make use only of incomplete clutches.

Having only one incubator, new eggs were continually being introduced as others hatched or became addled, and on this account it was deemed best to fix upon a temperature at the beginning of each season and maintain it as steadily as possible throughout. Guided by the usual practice among

poultry-rearers, I made the preliminary experiments at an average temperature of about 105° Fahr.; but believing this to be on the high side as regards the majority of our native birds, I reduced it in 1888 to 104° , and in 1889 still further to $102^{\circ}5$, in consequence of temperatures obtained by placing a small thermometer under a Domestic Hen, a Dove, and a Redpoll. The first two were sitting on eggs and gave 102° and $101^{\circ}5$ to 102° respectively. The Redpoll was placed on the thermometer lying on a sheet of cotton, and held there for fully twenty minutes, with the result that the mercury rapidly rose to $103^{\circ}75$, but soon fell again to 103° , at which it remained steady during the last ten minutes. In this connection the following statement by M. Georges Claraz (P. Z. S. 1885, p. 325) will be read with interest:—"Pour la *Rhea americana* . . . la température nécessaire est de 103° Fahr." Again, Mosenthal and Harting, in their book on 'Ostriches and Ostrich Farming,' say (p. 217) " 104° is the natural heat of the Ostrich mother," and recommend for the artificial hatching of Ostrich eggs " 102° Fahr. when first put in, to be gradually reduced to 100° at the end of two weeks, then in two weeks more to 98° ." The temperature in the mound of a British Turkey has been stated at 89° .*

The eggs in the incubator were looked at and turned twice a day—morning and evening—and the drawer left open from 15 to 20 minutes on each occasion.

From the outset it was evident that either several incubators would have to be used, or some other method of observation employed in conjunction with that already in use, if substantial results were to be obtained within a reasonable time. The only other courses were to watch the nests while the parents themselves incubated the eggs, or to place the eggs under domestic birds—Hen, Dove, or Canary, for instance, according to size. For several reasons I thought it better to avail myself, as far as possible, of both of these additional methods rather than to use more incubators. For valuable co-operation in watching nests of the Passeres, I am greatly indebted to my friend Mr. Bruce Campbell.

* Cassell's Birds, iii. p. 271.

The results of these experiments and observations will be found in the second, third, and fourth columns of the annexed Table. Column 4, showing under each species the number of eggs hatched, has been added so that, should the results be combined or compared with those of other observations, they may have no more than their proper weight assigned to them.

The number of species included in this part of the Table is seventy-five. Eggs of the Bearded Tit, Swift, Green Woodpecker, Kingfisher, Tawny Owl, Sparrow-Hawk, Ptarmigan, Water Rail, Redshank, Great Crested Grebe, and a few others were also tried, but without success. I should mention, however, that in each of these cases the experiment depended on a single egg, and that all of them had been transmitted by parcel-post from a distance, the rough handling thus encountered having, doubtless, at the outset destroyed the vitality of the greater number, if not, indeed, of all of them. To ensure success the eggs should be gathered as near home, carried with as little motion, and placed in the incubator with as little delay as possible. If they must travel a distance they cannot be too carefully packed. An excellent plan is to roll each egg in the centre of a thick ball of dry moss, and then pack them securely, in an upright position*, in a box of ample-size. Above all avoid the use of a hammer in fixing the lid. Six eggs of the Red-legged Partridge, packed in this fashion, and kindly sent by Lord Walsingham, all produced healthy chicks. The thick-shelled eggs of the gallinaceous birds appear, however, as a rule, to withstand the injurious effects of transit better than any others.

Differences of opinion doubtless exist as to how far results obtained by artificial means can be relied on as exponents of the duration of incubation under natural and normal conditions. For my own part, I have no hesitation in accepting them as substantially correct. No doubt individual cases may differ somewhat from the natural average, but not more so, I think, than is frequently the case among eggs naturally hatched. The extent to which development may be ac-

* Wright, in his 'Book of Poultry' (p. 42), strongly recommends the packing of the eggs with the large end down.

celerated or retarded without injuring the embryo is an interesting question, which I have not, so far, been able to investigate; but I imagine that, as regards the great majority of species, it is probably confined within comparatively narrow limits, say from one to two days either way. It is but natural to suppose that the limits of variation in this respect will be, to some extent at least, proportional to the whole period of incubation, so that in the case of species having a very long period—the Swan or the Ostrich, for instance—the variation in either direction may be expected to amount to several days. Newly laid Hens' eggs hatched some hours, or even a day, before those kept, say, a week.

Another point well worthy of investigation is the length of time eggs at different stages of incubation may be exposed to an insufficient temperature without destroying their vitality. Out of curiosity, more than anything else, I had a number of Sparrows', Blackbirds', Rooks', and Lapwings' eggs taken from the nests at different stages of development, and placed in the incubator after the lapse of various intervals up to fourteen or fifteen hours, and was surprised to find how many of them produced young birds in due course. The experiments were not sufficiently accurate or extensive to afford a basis for any precise conclusions, but in a general way they seem to point to this—that the eggs are least susceptible to harm before the blood-vessels have been formed and circulation set in; that the most critical time is immediately after circulation has been established; and that thereafter the power to resist the effects of exposure gradually increases as incubation progresses. I have placed in the incubator, after having carried them in my pocket for over twelve hours, eggs that had not been sat on more than a couple of days, and also others in which incubation was far advanced, and have found them hatch as if they had never been disturbed.

The literature of this subject is very scattered and fragmentary. The most comprehensive tabular statement I know of is that given by Tiedemann in his '*Anatomie und Naturgeschichte der Vögel*' (vol. ii. pp. 136–139), published so long ago as 1814. For the knowledge of this work, as well as of those of Thienemann, I am indebted to Professor

Newton, and through him to Dr. Gadow. Tiedemann's volume and the earlier of Thienemann's two I have not seen, and the references to these works are based on extracts (rendered in English) which Professor Newton has very kindly made for me. The Professor points out that Tiedemann gives no scientific names, but merely the German vernacular; and that while he has done his best to render them correctly by the help of Naumann, he cannot guarantee that he has in every instance given the right equivalent. I am further indebted to Professor Newton for a number of references to Naumann's great work on the birds of Germany, which is doubtless the origin of most of the periods given by subsequent authors. Mr. Selater's record of the duration of incubation in the case of birds which have bred in the gardens of the Zoological Society, contained in the Society's 'Proceedings' for 1859 (p. 205), and a very similar list given in the second volume of Owen's 'Anatomy of Vertebrates' (p. 257), supply much valuable information regarding non-European species. In addition to these, isolated statements are to be found in almost every work in which the habits of birds find a place. To have exhausted anything like the whole of the possible sources of information was an impossibility in the time at my disposal. Still I have been able to consult a goodly number of volumes, and the bulk of the material they have yielded (no small quantity) will be found in the right-hand side of the Table. No doubt much of it cannot be relied on, while not a little is in all probability mere repetition; and it is therefore not without considerable hesitation that I reproduce it so fully. Looking, however, to the present position of the subject, there is, it seems to me, much to be said for the course I have adopted.

A list of the works quoted will be found at the end of the paper. When Thienemann is quoted, the reference is to his 'Fortpflanzungsgeschichte,' unless otherwise stated.

The arrangement and nomenclature adopted in the Table are based on the 'B. O. U. List of British Birds' and Selater's 'List of Animals in the Zoological Gardens' (1883). In the case of most of the American birds the A. O. U. List has been followed.

TABLE OF PERIODS OF INCUBATION.

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TABLE (continued).

Author's Observations.		Previous Statements.	
Species.	Period.	Means employed.	Number of Eggs hatched.
<i>Sylvia cinerea</i> (Whitethroat.)	13th day (1st half of). 11 to 13 days from laying of last egg.	Incubator. 5 nests watched.	1
<i>Sylvia curruca</i> (Lesser Whitethroat.)	.....	.....	..
<i>Sylvia atricapilla</i> (Blackcap.)	.....	.....	..
<i>Sylvia hortensis</i> (Garden Warbler.)	12th day.	Incubator.	2
<i>Regulus cristatus</i> (Goldcrest.)	13th day.	For a time in Hedge Sparrow's nest, then removed to Willow Wren's.	1
<i>Phylloscopus rufus</i> (Chiffchaff.)	.....	.....	..
<i>Phylloscopus trochilus</i> (Willow Wren.)	13th day (end of). 13, 13, 14, and 16 days from laying of last egg.	Incubator. 4 nests watched.	1
<i>Aeroccephalus palustris</i> (Marsh Warbler.)	.....	.....	..
<i>Aeroccephalus turdoides</i> (Great Reed Warbler.)	.....	.....	..
<i>Acceator modularis</i> (Hedge Sparrow.)	14th day. 12th and 13th days from laying of last egg.	Incubator. 5 nests watched; at least one added egg in each.	1
		Period.	Reference.
		14 days.	Tiedemann's Table.
		10 days.	Bree, 'Field,' June 1871.
		12 to 14 days.	Neville Wood, p. 116.
		11 days.	Bree, 'Field,' June 1871.
		14 days.	Tiedemann's Table.
		15 days.	Bechstein, p. 226.
		Within a fortnight.	Cassell's Birds, ii. p. 242.
		13 days.	Naumann, iii. p. 591.
		13 days.	Brehm, quoted in 'Zoologist,' 1861, p. 7756.
		14 to 15 days.	Thiennemann, p. 190.
		12 to 13 days.	Thiennemann, p. 245.
		11 days.	Macgillivray, ii. p. 257.

TABLE (continued).

Species.	Author's Observations.			Previous Statements.	
	Period.	Means employed.	Number of Eggs hatched.	Period.	Reference.
<i>Motacilla lugubris</i> (Pied Wagtail.)	13th day.	Canary.	1		
<i>Anthus pratensis</i> (Meadow Pipit.)	13th and 14th days. 14th day from laying of last egg.	Incubator. Nest watched.	4	A fortnight. Generally 13 days.	Macgillivray, iii. p. 128. Cassell's Birds, ii. p. 175.
<i>Anthus trivialis</i> (Tree Pipit.)	13th day from laying of last egg.	Nest watched.			
<i>Icteria virens</i> (Yellow-breasted Chat.)	.....	.....	..	12 days.	Audubon, ii. p. 224.
<i>Seiurus noveboracensis</i> (Water-Thrush.)	.....	.....	..	14 days.	Audubon, i. p. 100.
<i>Oriolus galbula</i> (Golden Oriole.)	.....	.....	..	15 days. 14 to 15 days.	Tiedemann's Table. Thienemann, p. 292.
<i>Lanius excubitor</i> (Great Grey Shrike.)	.....	.....	..	15 to 16 days. 15 days. "	Tiedemann's Table. Audubon, ii. p. 534. Thienemann, p. 323.
<i>Lanius minor</i> (Lesser Grey Shrike.)	.....	.....	..	15 to 16 days. 15 days.	Tiedemann's Table. Saunders, p. 142.
<i>Lanius collurio</i> (Red-backed Shrike.)	.....	.....	..	14 days. A fortnight.	Bechstein, p. 36. Saunders, p. 143.
<i>Lanius pomeranus</i> (Woodchat.)	.....	.....	..	15 days.	Bechstein, p. 34.
<i>Vireo gilvus</i> (Warbling Vireo.)	.....	.....	..	12th day. 13 days.	Audubon, ii. p. 114. Thienemann, p. 299.
<i>Muscicapa grisola</i> (Spotted Flycatcher.)	13th day (middle of). 12½ to 13 days from lay- ing of last egg.	Canary. Nest watched.	1	14 days. 13 days.	Tiedemann's Table. Thienemann, p. 301.

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TABLE (continued).

Species.	Author's Observations.			Previous Statements.	
	Period.	Means employed.	Number of Eggs hatched.	Period.	Reference.
<i>Serinus canarius</i> (Canary.)	13 to 14 days.	Canaries.	17 (4 sets)	13 days.	Bechstein, p. 163. Syme, p. 169.
<i>Ligurinus chloris</i> (Greenfinch.)	14th day (1st half of).	Incubator.	1	13 to 15 days.	Cassell's Birds, i. p. 114.
<i>Passer domesticus</i> (Sparrow.)	13th and 14th days.	Incubator.	3	14 days. 13 or 14 days (<i>Passer montanus</i> same).	Tiedemann's Table. Cassell's Birds, i. pp. 134, 137.
<i>Fringilla cælebs</i> (Chaffinch.)	12th day (end of). 11 to 13 days from laying of last egg.	Incubator. 2 nests watched; 2 added eggs in each.	1	14 days. "	Tiedemann's Table. Thienemann, p. 413.
<i>Linota cannabina</i> (Linnet.)	14th day from laying of last egg.	Nest watched.	..	13 days. 12 days.	Owen's Table. Tiedemann's Table. Cassell's Birds, i. p. 123. Bree, 'Zoologist,' 1849, p. 2418.
<i>Erythropsiza githaginea</i> .. (Trumpeter Bullfinch.)	.....	.....	..	Within a fortnight.	Cassell's Birds, i. p. 102.
<i>Pyrrhula europæa</i> (Bullfinch.)	13th day (very end of).	Canary.	2	15 days. " "	Bechstein, p. 94. Tiedemann's Table. Owen's Table.
<i>Loxia pityopsittacus</i> (Parrot Crossbill.)	.....	.....	..	14 to 15 days.	Naumann, iv. p. 353.
<i>Loxia curvirostra</i> (Crossbill.)	.....	.....	..	14 days.	Tiedemann's Table.
<i>Emberiza citrinella</i> (Yellow-Hammer.)	14th day (2nd half of). 12 to 13 days from laying of last egg.	Incubator. 3 nests watched; added egg in two.	2	13 days. 14 days.	Tiedemann's Table. Saunders, p. 202.

<i>Icterus galbula</i> (Baltimore Oriole.)	.....	.....	..	Nearly a fortnight.	Audubon, i. p. 497.
<i>Molothrus ater</i> * (Cowbird.)	.....	.....	..		
<i>Sturnus vulgaris</i> (Starling.)	14th day.	For a time under Dove, and finally in incubator.	1	14 days. 17 to 18 days. About 16 days. About 16 days.	Tiedemann's Table. Syme, pp. 25 & 66. Neville Wood, p. 407. Yarrell, ii. p. 234 & footnote by Editor.
	12 to 13 (in one instance little more than 11) days from laying of last egg.	4 nests watched; an ad- dled egg in three.		"On this point obser- vers differ: Nau- mann says 14 days, Herr H. C. Müller (in the <i>Faroes</i>) 18."	
<i>Nucifraga caryocatactes</i> .. (Nutteracker.)	.....	.....	..	"Has been surmised to be 17 to 18 days."	Yarrell, ii. p. 335.
<i>Garrulus glandarius</i> (Jay.)	.....	.....	..	16 days.	Tiedemann's Table.
<i>Pica rustica</i> (Magpie.)	18th day (end of).	Incubator.	2	17 to 21 days' group.	Tiedemann's Table.
<i>Cyanopoliis cyaneus</i> (Chinese Blue Magpie.)	.....	.....	..	About 18 days.	Sclater, P. Z. S. 1885, p. 2.
<i>Corvus corone</i> and <i>C. cornix</i> (Carion and Hooded Crows.)	.....	.....	..	18 to 20 days.	Tiedemann's Table.
<i>Corvus frugilegus</i> (Rook.)	17th & 18th days. 14 to 17 days from lay- ing of last egg.	Incubator. 2 nests watched for me by Mr. Laidlaw; an addled egg in one.	4		
<i>Corvus corax</i> (Raven.)	18 to 19 days from lay- ing of last egg.	Nest watched for me by Mr. Harold Raeburn.	..	20 days. 19 " 20 days. Some 20 days.	Tiedemann's Table. Owen's Table. Audubon, ii. p. 5. Yarrell, ii. p. 262.

* "Eggs deposited in nests of Warblers, Vireos, and Sparrows, and said to hatch sooner than those of most birds" (Coues, 'Key to North-American Birds,' 1872, p. 155).

TABLE (continued).

Species.	Author's Observations.			Previous Statements.	
	Period.	Means employed.	Number of Eggs hatched.	Period.	Reference.
<i>Alauda arvensis</i> (Sky Lark.)	14th day.	Incubator.	2	14 days. " 15 to 16 days. About a fortnight. 15 days. "13 days as nearly as I can ascertain." About 15 days. 11 days?	Bechstein, p. 176. Tiedemann's Table. Syme, pp. 25, 73. Neville Wood, p. 255. Owen's Table. Saxby, p. 89. Yarrell, i. p. 617. A. M. Laws, 'Zoologist', 1890, p. 223.
<i>Alauda arborea</i> (Wood Lark.)			..	About 15 days.	Syme, p. 80.
<i>Alauda cristata</i> (Crested Lark.)			..	About a fortnight. A fortnight.	Cassell's Birds, i. p. 204. Saunders, p. 244.
<i>Cypselus apus</i> (Swift.)			..	16 or 17 days. 18 days.	Meyer, i. p. 183. Saunders, p. 252.
<i>Cypselus melba</i> (Alpine Swift.)			..	A little over 2 weeks. 18 to 21 days.	Naumann, vi. p. 121. Leo Zehntner*.
<i>Florisuga atra</i> (Black Humming-bird.)			..	12 days.	Tiedemann's Table (<i>fide</i> Audebert, Hist. Nat. Co- libris, p. 99).
<i>Trochilus colubris</i> (Ruby-throated Ditto.)			..	10 days.	Audubon, i. p. 251.

<i>Caprimulgus europaeus</i> (Nightjar.)	.....	.....	18 days.	Gurney, 'Zoologist,' 1883, p. 429.
<i>Chordeiles virginianus</i> (Night Hawk).	.....	.....	A fortnight.	Audubon.
<i>Picus martius</i> (Great Black Wood- pecker.)	.....	.....	16 to 18 days. Towards 18 days.	Naumann, v. p. 266. Thienemann, p. 98.
<i>Dendrocopus major</i> (Great Spotted Wood- pecker.)	.....	.....	14 to 16 days. About a fortnight.	Naumann, v. p. 310. Saunders, p. 266.
<i>Dendrocopus medius</i> (Middle Spotted Wood- pecker.)	.....	.....	15 days.	Naumann, v. p. 332.
<i>Dendrocopus minor</i> (Lesser Spotted Wood- pecker.)	.....	.....	14 days. "	Thienemann, p. 97. Morris, ii. p. 29.
<i>Geococcyx viridis</i> (Green Woodpecker.)	.....	.....	16 to 18 days.	Thienemann, p. 100.
<i>Lynx torquilla</i> (Wryneck.)	.....	.....	14 days. "	Tiedemann's Table. Thienemann, p. 93.
<i>Alcedo ispida</i> (Kingfisher.)	.....	.....	14 days. 15 to 16 days.	Tiedemann's Table. Thienemann, p. 103.
<i>Halcyon vagans</i> (New - Zealand King- fisher.)	.....	.....	19 days.	Buller (<i>vide</i> W. W. Smith), i. p. 126.
<i>Ceryle alcyon</i> (Belted Kingfisher.)	.....	.....	16 days. "	Audubon, i. p. 396. Owen's Table.
<i>Coracias garrula</i> (Roller.)	.....	.....	18 or 20 days. 20 days. Not quite 3 weeks. About 3 weeks.	Bechstein, p. 45. Tiedemann's Table. Naumann, ii. p. 166. Yarrell, ii. p. 432.
<i>Upupa epops</i> (Hoopoe.)	.....	.....	16 days. " "	Tiedemann's Table. Naumann, v. p. 454. Yarrell, ii. p. 424.

* 'Beiträge zur Entwicklung von *Cypselus melba*.' Dissertation. Berlin, 1890. (Per Dr. Gadow.)

TABLE (continued).

Species.	Author's Observations.	Previous Statements.
<i>Cuculus canorus</i> (Cuckoo.)	Period.	Reference.
<i>Haploiderma narina</i> (Narina Trogon.)	13 to 14 days by inference.	
<i>Cacatua cristata</i> (Great White-crested Cuckatoo.)	In Pipit's nest, hatched along with rightful occupants.	Number of Eggs hatched.
<i>Cacatua goffini</i> (Goffin's Cuckatoo.)		Period.
<i>Cacatua roseicapilla</i> (Roseate Cuckatoo.)		
<i>Licmetis tenuirostris</i> (Slender-billed Cuckatoo.)		
<i>Calopsitta nove-hollandica</i> (Cockateel.)		
<i>Trichoglossus nove-hollandica</i> (Swainson's Lorikeet.)		
	Means employed.	Number of Eggs hatched.
		Period.
		Reference.

<i>Euphemia pulchella</i> (Tonquinensis Parakeet.)	.....	.....	.....	About 18 days.	Greene, i. p. 78.
<i>Euphemia splendida</i> (Splendid Grass Parakeet.)	.....	.....	.....	About 18 days.	Greene, i. p. 100.
<i>Euphemia bourkii</i> (Bourke's Parakeet.)	.....	.....	.....	About 17 days.	Greene (<i>vide</i> Groom), i. p. 108.
<i>Melopittacus undulatus</i> (Waved Parakeet.)	.....	.....	.....	16 to 20 days.	Brehm, i. 149.
	.....	.....	.....	18 to 20 days.	According to many observations by M. Braun*.
<i>Cyanorhynchus novae-zealandiae</i> (New-Zealand Parakeet.)	.....	.....	.....	About 18 days.	Greene, ii. p. 14.
<i>Psittacus haematodus</i> (Blood-rumped Parakeet.)	.....	.....	.....	About 17 days.	Greene (<i>vide</i> Dalton), ii. p. 31.
<i>Lathyrus discolor</i> (Swift Parakeet.)	.....	.....	.....	21 days.	Greene (<i>vide</i> Rousse), ii. p. 36.
<i>Ara urarina</i> (Blue-and-Yellow Macaw.)	.....	.....	.....	20 to 25 days.	Greene (<i>vide</i> Lamouroux), ii. p. 77.
<i>Asio otus</i> (Long-eared Owl.)	.....	.....	Incubator.	21 to 24 days' group†.	Tiedemann's Table.
	.....	.....	.....	3 weeks.	Cassell's Birds, ii. p. 98.
	.....	.....	.....	About 20 days.	Dresser, v. p. 255.
<i>Syrnium aluco</i> (Tawny Owl.)	.....	.....	.....	32 days. (In Mr. Fourn-	Naumann, i. p. 480.
<i>Nyctea scandiaca</i> (Snowy Owl.)	.....	.....	.....	32 days, or 30 to 33 to 34 days, or 30 to 32, according to the taine's aviary.)	Greene, Ibis, 1875, p. 518.
	.....	.....	.....	2 that did not hatch.	Greene, Ibis, 1880, p. 472.

* In 'Arbeiten des zoolog. Instituts zu Würzburg,' v. 1882, &c., as I am informed by Dr. Gadow.
† Tiedemann does not give the period for each species separately, but divides them more or less into groups.

TABLE (continued).

Species.	Author's Observations.		Previous Statements.	
	Period.	Means employed.	Number of Eggs hatched.	Period.
<i>Bubo ignavus</i> (Eagle Owl.)			..	21 to 24 days' group. 36 days, reckoned from laying of first egg to hatching and 1851, p. 3145, referring to 3 broods hatched in Mr. Fountaine's aviary.
<i>Athene noctua</i> (Little Owl.)			..	14 to 16 days. 28 days. Naumann, i. p. 499. Saunders (<i>vide</i> Meade-Waldo), p. 292.
<i>Circus cygnus</i> (Marsh Harrier.)			..	21 to 24 days' group. Tiedemann's Table.
<i>Circus cygnus</i> (Hen Harrier.)			..	21 to 24 days' group. 3 weeks. Tiedemann's Table. Saunders, p. 308.
<i>Buteo vulgaris</i> (Buzzard.)			..	3 weeks. " " Saunders, p. 312.
<i>Aquila neva</i> or <i>clanga</i> .. (Spotted Eagle.)			..	"Said to sit 3 weeks." Seebohm, i. p. 109.
<i>Aquila chrysaetus</i> (Golden Eagle.)			..	30 days. "About 21 days." Owen's Table.
<i>Aquila imperialis</i> (Imperial Eagle.)			..	5 weeks. Cassell's Birds, ii. p. 12.
<i>Circus gallicus</i> (Short-toed Eagle.)			..	About 28 days. Cassell's Birds, ii. p. 50.

<i>Nisaetus fasciatus</i> (Bonelli's Eagle.)	.....	.....	..	40 days (from laying of first egg to hatching of both.)	Dresser, v. p. 581. Nest at Gibraltar observed by Col. Irby.
<i>Accipiter nisus</i> (Sparrow-Hawk.)	.....	.....	..	18 to 19 days. 3 weeks.	Tiedemann's Table. Meyer, i. p. 31.
<i>Milvus ictinus</i> (Kite.)	.....	.....	..	21 to 24 days' group.	Tiedemann's Table.
<i>Pernis apivorus</i> (Honey Buzzard.)	.....	.....	..	3 weeks.	Seebohm, i. p. 71.
<i>Falco peregrinus</i> (Peregrine Falcon.)	.....	.....	..	18 to 19 days. One month. 3 weeks.	Tiedemann's Table. Macgillivray, iii. p. 307. Meyer, i. p. 38.
<i>Falco subbuteo</i> (Hobby.)	.....	.....	..	3 weeks.	Seebohm, i. p. 33.
<i>Tinnunculus alaudarius</i> .. (Kestrel.)	27 to 28 days from laying of last egg.	Nest watched for me by Rev. Julian Tuck. 3 eggs (out of 5) hatched.			
<i>Serpentarius reptilivorus</i> .. (Secretary Vulture.)	.....	.....	..	About 6 weeks.	Brehm, i. p. 606.
<i>Cathartes atrata</i> (Black Vulture.)	.....	.....	..	32 days.	Audubon, ii. p. 42.
<i>Cathartes californianus</i> .. (Californian Vulture.)	.....	.....	..	29 to 31 days.	Audubon (<i>fide</i> Douglas), v. p. 242.
<i>Phalacrocorax carbo</i> (Cormorant.)	.....	.....	..	28 to 29 days. (In Zool. Gardens.)	'Field,' April 22, 1882, and Yarrell, iv. p. 148.
<i>Sula bassana</i> (Gannet.)	One hatched on 39th day; the other had a live chick in it on the 42nd day, which, however, died in the shell.	Domestic Hen.	2	43 days, and 45 days from date of laying. (In Booth's aviary.) 6 weeks at least.	Booth, pt. v. pp. 10, 12. Naumann, xi. p. 36.
<i>Pelecanus</i> , sp.? (Pelican.)	.....	.....	..	30 days.	Tiedemann's Table.

TABLE (continued).

[illegible]

<i>Chenalopex egyptiaca</i>	(Egyptian Goose).	.....	.....	.....	27 to 28 days.	Cassell's Birds, iv. p. 139.
<i>Anser cinereus</i>	(Grey-lag Goose.)	.....	.....	.....	28 days.	Tiedemann's Table.
<i>Anser domesticus</i>	(Domestic Goose.)	.....	.....	.....	27 to 28 days.	Naumann, xi. p. 261.
<i>Anser brachyrhynchus</i>	(Pink-footed Goose.)	.....	.....	.....	28 days.	Cecil Smith, 'Zoologist' (1872), p. 3243.
<i>Bernicla canadensis</i>	(Canada Goose.)	28 to 29 days.	Hen.	3	28 days.	Audubon, iii. p. 7.
<i>Bernicla poliocephala</i>	(Ashy-headed Goose.)	.....	.....	..	30 days.	Sclater, P. Z. S. 1859, p. 205.
<i>Bernicla sandvicensis</i>	(Sandwich-Island Goose.)	.....	.....	..	31 days.	Sclater, P. Z. S. 1859, p. 205.
<i>Cygnus olor</i>	(Mute Swan.)	.....	.....	..	5 weeks.	Beechstein, p. 303.
					35 days.	Tiedemann's Table.
					36 to 39 days.	Naumann, xi. p. 471.
					6 weeks.	Varrell, iv. p. 325.
					"Usually 5 weeks, or	Stevenson, iii. p. 70.
					about a week longer,	
					should the weather	
					be very cold."	
<i>Cygnus muscus</i>	(Whooper.)	.....	.....	..	5 weeks.	Naumann, xi. p. 494.
					6 weeks.	Selby, ii. p. 280.
					42 days.	Varrell, iv. p. 311.
<i>Cygnus nigricollis</i>	(Black-necked Swan.)	.....	.....	..	35 days.	Sclater, P. Z. S. 1859, p. 205.
<i>Cygnus atratus</i>	(Black Swan.)	.....	.....	..	35 days.	Sclater, P. Z. S. 1859, p. 205.

TABLE (continued).

Species.	Author's Observations.			Previous Statements.	
	Period.	Means employed.	Number of Eggs hatched.	Period.	Reference.
<i>Tadorna cornuta</i> (Common Sheldrake.)	.....	.....	..	30 days. " 4 weeks. From 3 to 4 weeks. 28 to 30 days. 26 days.	Selby, ii. p. 290. Owen's Table. Dresser, vi. p. 460. Seebohm, iii. p. 522. Yarrell, iv. p. 355. Cassell's Birds, iv. p. 148.
<i>Tadorna casarca</i> (Ruddy Sheldrake.)	.....	.....	..	30 days.	Sclater, P. Z. S. 1859, p. 205.
<i>Mareca penelope</i> (Wigeon.)	.....	.....	..	24 to 25 days.	Naumann, xi. p. 742.
<i>Anas domesticus</i> (Domestic Duck.)	27th and early on 28th day.	Hen.	10		
<i>Anas boschas</i> (Wild Duck.)	26th day (1st half of). 26th day (1st half of).	Incubator. Put under a brooding Wild Duck, in place of her own eggs.	1 12	28 days. 4 weeks.	Tiedemann's Table. Macgillivray, v. p. 37.
	25th(end of) & 26th day. 25th day (end of).	Hen. Hen.	10 2		
<i>Dafile acuta</i> (Pintail.)	.....	.....	..	More than 3, less than 4 weeks. 22 or 23 days.	Naumann, xi. p. 656. Meyer, vi. p. 96.
<i>Anas angustirostris</i> (Marbled Duck.)	.....	.....	..	25 to 27 days.	Dresser (<i>fide</i> M. Favier), vi. p. 480.
<i>Querquedula circia</i> (Garganey.)	.....	.....	..	21 or 22 days. 21 to 22 days.	Naumann, xi. p. 697. Seebohm, iii. p. 553.
<i>Querquedula crecca</i> (Common Teal.)	22nd day (end of).	Incubator.	3	"Seldom sits more than 3 weeks."	Seebohm, iii. p. 547.

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* This Duck did not sit very well at first.

TABLE (continued).

Species.	Author's Observations.			Previous Statements.	
	Period.	Means employed.	Number of Eggs hatched.	Period.	Reference.
<i>Turtur communis</i> (Turtle Dove.)	.....	.....	..	16 to 17 days. " A fortnight. About a fortnight.	Tiedemann's Table. Thienemann, p. 59. Yarrell, iii. p. 22. Saunders, p. 474.
<i>Turtur risorius</i> (Collared Turtle Dove.)	15th day (2nd half) and early on 16th day.	Incubator.	2	A fortnight.	Bechstein, p. 288.
<i>Ocyphaps lophotes</i> (Crested Pigeon.)	.....	.....	..	14 days.	Slater, P. Z. S. 1859, p. 205.
<i>Columba nicobarica</i> (Nicobar Pigeon.)	.....	.....	..	28 days. (In Zool. Gardens.)	Bartlett, P. Z. S. 1866, p. 78.
<i>Goura coronata</i> (Crowned Pigeon.)	.....	.....	..	28 days. (Ditto.)	Slater, P. Z. S. 1859, p. 205. Owen's Table.
<i>Pterocles alchata</i> (Pin-tailed Sand-Grouse.)	.....	.....	..	About 25 days. (In Zool. Gardens.)	Bartlett, P. Z. S. 1866, p. 78.
<i>Syrhaptes paradoxus</i> (Pallas's Sand-Grouse.)	.....	.....	..	28 days. (Incubator at the Zool. Gardens, Amsterdam.)	F. E. Blaauw, Ibis, 1890, p. 466.
<i>Tetrao urophasianus</i> (Sage Grouse.)	.....	.....	..	21 to 22 days.	Thienemann, p. 45.
<i>Tetrao urogallus</i> (Capercaillie.)	26th day (2nd half of). 26th day (1st half of). 26th day.	Hen. Hen. Hen.	1 8 4	28 days. " About 4 weeks. Said to be a month.	Tiedemann's Table. Owen's Table. Thienemann, p. 41. Dresser (<i>vide</i> Lloyd), vii. p. 231.
				About a month. About 3 weeks.	Yarrell, iii. p. 54. Badminton Library, ii. p. 54.

(Black Grouse.)	Cupidonia cupido																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															</
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* An anonymous writer in 'Shooting Times' of June 16th, 1888, gives 23 days as the period for these two species.

<i>Euplocamus nycthemerus</i> .. (Silver Pheasant.)	26 days.	Hen.	Several.	24th day. 26 to 28 days' group. 26 days.	Tegetmeier (<i>vide</i> Hewitt), p. 118. Tiedemann's Table. Thienemann, p. 19.
<i>Euplocamus horsfieldi</i> (Purple Kaleege.)	.....	.....	..	24 days.	Sclater, P. Z. S. 1859, p. 205.
<i>Euplocamus melanotis</i> (Black-backed Kaleege.)	.....	.....	..	24 days.	Sclater, P. Z. S. 1859, p. 205.
<i>Euplocamus albo-cristatus</i> .. (White-crested Kaleege.)	.....	.....	..	26 days.	Sclater, P. Z. S. 1859, p. 205.
<i>Gallus domesticus</i> (Domestic Hen, Dorking var.)	20th and 21st day. 20th and (mostly) 21st day.	Incubator. Hen. These and the above were taken at random from the same lot of eggs and set at the same time. Those in the incubator hatch- ed on the average 5 or 6 hours in advance of those under the hen.	11 12		
<i>Gallus domesticus</i> (Bantam.)	21st day (1st half of).	Bantam.	4		
<i>Gallus varius</i> (Fork-tailed Jungle-fowl.)	.....	.....	..	3 weeks.	Thienemann, p. 19.
<i>Cerionis satyra</i> (Horned Tragopan.)	.....	.....	..	28 days.	Misselbrook, P. Z. S. 1879, pp. 117, 118.
<i>Cerionis temmincki</i> (Temminck's Tragopan.)					
<i>Pavo cristatus</i> (Peafowl.)	.....	.....	..	28 days. 28 " 30 days; and 28 days.	Tiedemann's Table. Thienemann, p. 13. Wright, pp. 49 & 530.
<i>Polyplectron chinquis</i> (Peacock Pheasant.)	.....	.....	..	21 days.	Misselbrook, P. Z. S. 1879, p. 117.

TABLE (continued).

Species.	Author's Observations.			Previous Statements.	
	Period.	Means employed.	Number of Eggs hatched.	Period.	Reference.
<i>Argus giganteus</i> (Argus Pheasant.)	.....	.....	..	24 days under parent; the same under Bantam Hen.	Misselbrook, P. Z. S. 1879, pp. 115, 116.
<i>Meleagris gallo-pavo</i> (North-American Turkey.)	.....	.....	..	26 to 28 days. 31 " days; hatched at Ardlamont.	Tiedemann's Table. Thienemann, p. 14. J. Gilmour, Proc. Nat. Hist. Soc. Glasgow, ii. p. 15.
<i>Meleagris gallo-pavo</i> (Domestic var.)	28th day.	Turkey.	8		
	28th and early on 29th day.	Large Hen.	11		
	28th day (2nd half of).	Bantam.	4		
<i>Numida meleagris</i> (Guinea-fowl.)	.....	.....	..	25 days. "	Tiedemann's Table. Thienemann, p. 16.
<i>Rallus crepitans</i> (Clapper Rail.)	.....	.....	..	14 days.	Audubon, iii. p. 34.
<i>Porzana maruetta</i> (Spotted Crane.)	.....	.....	..	3 weeks.	Naumann, ix. p. 543.
<i>Porzana parva</i> (Little Crane.)	.....	.....	..	21 to 24 days' group.	Tiedemann's Table.
<i>Crex pratensis</i> (Corn Crane.)	.....	.....	..	21 to 24 days' group. 3 weeks.	Tiedemann's Table. Cassell's Birds, iv. p. 102.
<i>Gallinula chloropus</i> (Moorhen.)	21st day (beginning of).	Incubator.	1	21 to 24 days' group.	Tiedemann's Table.
	1 end of 19th, rest on the 20th day.	Hen.	4	About 3 weeks. About 21 days.	Montagu, i. Macgillivray (<i>fide</i> Harley), iv. p. 552.
	20th day (2nd half of).	Hen.	2		
	21st day (early on).	Hen.	1	3 weeks.	Selby, ii. p. 190.
	20 to 21 days from lay-	Nest watched.			Yarrell, iii. p. 167.

TABLE (continued).

Species.	Author's Observations.			Previous Statements.	
	Period.	Means employed.	Number of Eggs hatched.	Period.	Reference.
<i>Vanellus vulgaris</i> (Lapwing.)	2 hatched on 25th, 1 on 26th (exact time 25 days 16 hours), and 2 on 27th day. During 26th day from laying of last egg.	Incubator. Nest watched.	6	16 days. "	Tiedemann's Table. Naumann, vii. p. 293.
<i>Hamatopus ostralegus</i> (Oyster-catcher.)	23 to 24 days from time when the nests were discovered, each then containing the full complement of 3 eggs.	2 nests watched for me by Col. Duthie, who is confident the last egg in each case could not have been laid many hours previous to his finding the nest.	..	21 to 24 days' group. About 3 weeks. "	Tiedemann's Table. Yarrell, iii. p. 296. Saunders, p. 544.
<i>Recurvirostra avocetta</i> (Avocet.)	.....	.....	..	17 or 18 days.	Naumann, viii. p. 232.
<i>Scolopax rusticola</i> (Woodcock.)	20th day from laying of last egg.	Nest watched.	..	16 to 18 days. 17 days. 21 days at least (bird flushed off 4 eggs 28th April, hatched 19th May).	Tiedemann's Table. Naumann, viii. p. 393. Stevenson, 'Zoologist,' 1859, p. 6602, and 'Birds of Norfolk,' ii. p. 289.
<i>Gallinago major</i> (Great Snipe.)	.....	.....	..	16 to 18 days. 17 or 18 days. 18 days. 17 to 18 days.	Tiedemann's Table. Naumann, viii. p. 307. Yarrell, iii. p. 339. Dresser, vii. p. 638.
<i>Gallinago caelestis</i> (Common Snipe.)	20th day from laying of last egg.	Nest watched.	..	16 to 18 days. Rather more than a fortnight.	Tiedemann's Table. Yarrell, iii. p. 345.

(Dunlin.)	21 days from finding of nest with 4 eggs.	Nest watched.			
<i>Machetes pugnax</i> (Ruff.)	.....	.....	..	16 days. 17 to 19 days.	Tiedemann's Table. Cassell's Birds, iv. p. 42.
<i>Totanus hypoleucus</i> (Common Sandpiper.)	22nd day.	Incubator.	2	2 weeks.	Naumann, viii. p. 30.
<i>Totanus ochropus</i> (Green Sandpiper.)	.....	.....	..	21 to 24 days' group.	Tiedemann's Table.
<i>Totanus calidris</i> (Redshank.)	.....	.....	..	14 to 16 days. About 16 days. "	Naumann, viii. p. 118. Yarrell, iii. p. 471. Saunders, p. 602.
<i>Numenius arquata</i> (Curlew.)	30th day (early on).	Incubator.	2	21 to 24 days' group.	Tiedemann's Table.
<i>Sterna fluviatilis</i> (Common Tern.)	One late on 22nd, the others on 23rd day.	Incubator.	3	14 to 16 days.	Tiedemann's Table.
<i>Sterna arctica</i> (Arctic Tern.)	.....	.....	..	15 or 16 days.	Naumann, x. p. 140.
<i>Sterna minuta</i> (Little Tern.)	.....	.....	..	14 to 16 days. A fortnight.	Tiedemann's Table. Meyer, vii. p. 97.
<i>Sterna caspia</i> (Caspian Tern.)	.....	.....	..	About 20 days.	Meyer, vii. p. 73.
<i>Hydrochelidon nigra</i> (Black Tern.)	.....	.....	..	15 or 16 days.	Naumann, x. p. 211.
<i>Rissa tridactyla</i> (Kittiwake.)	26th day.	Incubator.	1		
<i>Larus glaucus</i> (Glaucous Gull.)	.....	.....	..	4 weeks.	Naumann, x. p. 365.
<i>Larus argentatus</i> (Herring Gull.)	26th day.	Hen.	1		
<i>Larus ridibundus</i> (Black-headed Gull.)	2 out on 22nd, 4 on 23rd, and 1 on 24th day. 23 to 24 days from laying of 1st egg.	Incubator. Nest watched.	7	14 to 16 days. About 17 days. 3 weeks.	Tiedemann's Table. Yarrell, iii. p. 602. Plot, as quoted in Yarrell, iii. p. 599.

<i>Podiceps minor</i> (Little Grebe.)	.....	.....	..	21 to 24 days' group. 20 or 21 days.	Tiedemann's Table. Cassell's Birds, iv. p. 245.
<i>Alca torda</i> (Razorbill.)	30th day.	Incubator. May not have been an abso- lutely fresh egg.	1	About 4 weeks. About a month.	Macgillivray, v. p. 355. Seebohm, iii. p. 377.
<i>Lomvia troile</i> (Guillemot.)	30th and 33rd days. 31st day (end of).	Incubator. Hen.	2 1	28 days. A month. Appears to last a month. 30 days. Fully 30 days? Nearly a month.	Tiedemann's Table. Selby, ii. p. 421. Macgillivray, v. p. 321. Owen's Table. Saxby, p. 290. Yarrell, iv. p. 70.
<i>Uria grylle</i> (Black Guillemot.)	.....	.....	..	24 days.	Cassell's Birds, iv. p. 251.
<i>Fratercula arctica</i> (Puffin.)	36th day.	Incubator.	1	A month. "Some observers say 5 weeks." 30 days. About a month.	Selby, ii. p. 440. Yarrell, iv. p. 92. Cassell's Birds, iv. p. 263. Owen's Table. Seebohm, iii. p. 367.
<i>Eudyptes chrysocome</i> (Tufted Penguin.)	.....	.....	..	About 6 weeks. *Probable time, ac- cording to Studer, 30 to 35 days.	Thomson's Voyage of the 'Challenger,' p. 167 (quoted by Buller). Zeitschrift für wissen- schaftliche Zoologie, xxx. pp. 421-436.
<i>Rhynchotus rufescens</i> (Rufous Tinamou.)	.....	.....	..	21 days (hatched in Zool. Soc. Gardens).	Bartlett, P. Z. S. 1868, p. 115.
<i>Apteryx australis</i> (Kiwi.)	.....	.....	..	6 weeks (according to a native).	Gould, as quoted in Cas- sell's Birds, iii. p. 310.

* Dr. Gadow, who sends me this reference, thinks that the period is more likely to be 35 to 40 days.

TABLE (continued).

Species.	Author's Observations.			Previous Statements.	
	Period.	Means employed.	Number of Eggs hatched.	Period.	Reference.
<i>Casuaris galeatus</i> ? (Cassowary.) <i>Casuaris bennetti</i> . (Mooruk.)			..	9 weeks.	Thienemann, p. 2.
			..	7 weeks.	Slater, P. Z. S. 1863, p. 234.
			..	48 days. 52 days.	Owen's Table. Mosenthal & Harting, p. 130.
<i>Dromæus nove-hollandia</i> . (Emu.)			..	56 days (hatched in incubator at the Zool. Soc. Gardens).	Slater, P. Z. S. 1859, p. 205, 1863, p. 234.
			..	58 days; hatched by male bird in Dumfriesshire.	Gibson, Proc. R. Phys. Soc. iv. p. 210.
			..	"Fully 9 weeks elapsed before the eggs on which the bird sat were hatched." "The normal period of incubation is about 60 days."	Mosenthal & Harting, pp. 160, 173.
<i>Struthio canus</i> (Ostrich.)			..	36 to 40 days.	Tiedemann's Table (quoting from Lichtenstein's 'Reise,' ii. p. 42).
			..	1 out in 39 days, 4 others shortly afterwards (in Italy); 44 days (in France).	'Zoologist,' 1861, pp. 7316, 7758.

Sclater, P. Z. S. 1863, p. 233.

45 days. "This, however, would appear to have been before the expiration of the usual period of incubation, which, according to the observations of Mr. Hardy, of Algiers, lasts usually from 56 to 60 days."

50 to 60 days.

42 days. From experience at an Ostrich farm in Cape Colony where incubators were used.

5 weeks.

35 days (hatched in incubator at the Zool. Soc. Gardens).

30 to 31 days.

"46th day from the cock commencing to sit."

"The male bird sat for 40 days exactly."

35 days in the incubator, "which is somewhat less than the time occupied when hatched in the natural way."

Owen, p. 256. Mosenthal & Harting, p. 215.

Thienemann, p. 4. Sclater, P. Z. S. 1859, p. 205, 1863, p. 234.

Owen's Table. Claraz, P. Z. S. 1885, p. 324.

Mosenthal & Harting, pp. 18, 83, 92.

Rhea americana (Common Rhea.)

.....

.....

..

A glance at the Table reveals a host of discrepancies, many of which it is impossible, in the present state of our knowledge, to reconcile or account for. Regarding the periods obtained by observation of the nests, an obvious source of error lies in the difficulty of determining when the birds really begin to sit. A very natural point to reckon from is the date of laying of the last egg; but this frequently leads to serious error, as many species habitually, and others occasionally, sit before the last egg has been laid; while others, again, either do not sit at all, or only partially, for some time afterwards. As examples of the extent of the error involved in this way of reckoning, I would point to the cases in my own experience of the Long-tailed Tit and the Starling, the former not hatching for fully 16 days from the laying of the last egg, while the latter were out, in one instance, in little more than 11. Neither is it safe to count to the hatching of the last of the young, unless each egg be numbered when laid, as the last laid egg is often unfertile. By means of the incubator all these difficulties are overcome.

It seems quite unnecessary for me to discuss in detail the contents of the Table, but a few remarks upon each of the Orders may not be deemed out of place.

In the Order *Passeres*—among the European species, at any rate—we may take it as well-nigh certain that the normal period ranges from about 12 days in the case of the smallest (the Goldcrests), to 19 or 20 days in the case of the largest (the Raven). 13 to 14 days is a very common period among the great majority of the smaller members of the Order; and even the Thrushes require no more than from 14 to 15 days, a remarkably short period when we consider the size of their eggs as compared, for example, with those of the Wren, which I have shown require about 13 days. The Starling is another example of very rapid development. Owen gives 10 days as the time for the Wren; but this is not borne out by my observations. The shortest period I have seen recorded is that of the tiny New-Zealand *Zosterops cerulescens*, namely, 9 to 10 days, as given by Buller on the authority of Mr. Potts, evidently a careful and systematic observer. The *Corvidæ* stand quite alone in the

Order, having a decidedly longer period than any of their neighbours.

The *Picariæ* do not appear to differ to any marked extent from the *Passeres* in the duration of incubation. Should the data now brought together be confirmed by future observations, the Picarian periods will be slightly the longer of the two, when measured with due regard to the size of the eggs. Such tiny creatures as the Ruby-throated and the Black Humming-bird do not, according to Audubon and Audebert, take less than 10 to 12 days, and the larger forms of Woodpecker and Kingfisher, and the Roller, take from 18 to 20.

If the information as to the Parrots (*Psittaci*) be correct, they hatch in less time than I should have expected in view of their reputed longevity, for I believe there is an intimate connection between the period of incubation and the average lifetime of the bird.

Though the statements regarding the Owls (*Striges*) are rather conflicting, the weight of evidence is all in favour of a long period of incubation, an egg of the Long-eared Owl, which is scarcely bigger than that of the Ring Dove, taking fully 26 days to hatch in the incubator*. The Eagle Owl and the Snowy Owl may be held to take about 32 or 33 days.

The Diurnal Birds of Prey (the *Accipitres*) are, undoubtedly, also a long-period race, notwithstanding some of the records quoted. For instance, Tiedemann's statement that the Peregrine hatches in 18 to 19 days must be set aside as erroneous, and so likewise must Elwes's 21 days for the Golden Eagle. In all probability the former bird sits not less than 4 weeks, and the latter nearer 5. I regret that I failed to hatch any Hawks' eggs in the incubator, but the Rev. Julian Tuck's observations on the Kestrel, made at my special request, on a nest in the tower of the church at Bury St. Edmunds in the spring of 1889, proves the time in that species to be little, if at all, short of 4 weeks.

Among the *Steganopodes* the Solan Goose has a remarkably

* Several other eggs of this Owl were hatched, but, not being perfectly fresh when obtained, have not been entered in the Table, though the periods were quite in keeping with the one above mentioned.

long period, six weeks or thereabout. The great difference between the Cormorant's period and that of the Gannet is worthy of notice in connection with the fact that the former lays from 3 to 5 eggs, while the latter only lays 1.

The statements regarding the *Herodiones* are very conflicting, but I think we may hold their periods of incubation to be much on a par with those of the *Anseres*. Taking the Common Heron as a typical example of the Order, we have a period apparently identical with that of the Wild Duck, namely, 25 to 26 days, and their eggs may be said to be much about the same size. According to Naumann the Little Bittern takes from 16 to 17 days only, and we have the Stork set down at 30 days by Macgillivray.

In the case of the *Anseres* we are on much surer ground, the duration of incubation passing very naturally from 3 weeks in the smaller Ducks to about 30 days in the typical Geese, and on to 35 to 40 days in the Swans. A very common opinion in regard to the Ducks is that they all sit 28 days; but I think my experiments prove that the eggs of the Common Wild Duck hatch in from 25 to 26 days, and those of the Teal in from 21 to 22. The Flamingos are probably very similar to the Geese in this respect.

Judging by the time our own Common Pigeons—wild and tame—take to hatch (15 to 17 days), I had come to look on the *Columbæ* as a short-period group, and consequently was much surprised to find that the Nicobar and the Crowned Pigeons in the Zoological Society's Gardens took no less than 28 days to bring out their young.

It is gratifying to be able to include in my list two species of the limited Order *Pterocles*, namely the Pin-tailed and the Pallas's Sand-Grouse. The periods given, 25 and 28 days respectively, do not bear out a statement I have somewhere seen, to the effect that the duration of incubation in the case of *Syrrhaptes paradoxus* is unusually short.

The *Gallinæ* present less variation than we might expect when their great diversity of size is considered. The Quails require about 3 weeks, and a week more suffices for a Turkey. It seems strange that the period of incubation in the case

of the Common Partridge should have been so persistently stated by authors to be 21 days instead of about 24.

The *Fulicariæ* and *Alectorides* do not seem to call for any special remarks. The *Limicolæ*, however, deserve a few words. According to our present information the period ranges from about 20 days in the case of the Snipes to 29 in the Curlew. It is more protracted among the Plovers and Sandpipers—the Ring Plover and Dunlin, for example, taking fully 3 weeks—than one would expect if the size of the birds alone be considered; but we must bear in mind the disproportionately large eggs they lay. Respecting this group, little or no reliance can be placed on Tiedemann's Table; and Naumann and others are undoubtedly in error in stating that species such as the Redshank hatch in from 14 to 16 days. Neither do I believe in the duration of incubation (about 18 days) assigned by Saxby to the Golden Plover. In the case he cites, the fact that the egg he broke appeared fresh is no proof that the other three eggs in the nest were fresh. It was most probably an unfertile egg. I was once misled in this very way with regard to the eggs in a Lark's nest. I should mention that many of the *Limicolæ* remain in the egg from 2 to 3 days after chipping.

Size for size, the eggs of the *Gaviæ* probably require periods much like those of the *Limicolæ*. Tiedemann greatly understates them, and Yarrell's 17 days for the Black-headed Gull is about a week short of the actual time.

Our information regarding the *Tubinares* is too meagre to justify anything but the very general assumption that incubation is with them a much protracted process, probably well over 3 weeks in the case of the small Petrels—whose eggs are no bigger than Thrushes'—and extending, according to Mr. W. Dougall, who spent a considerable time in Auckland Island, to 60 days in the case of one of the Albatrosses, and that not the largest. Thienemann's statement that the Fulmar requires from 56 to 60 days can scarcely be credited. Macgillivray tells us that when his son visited St. Kilda on 30th June, 1840, the Fulmars' second eggs were just hatching, the first nests having "all been robbed about a month before."

The *Pygopodes*, particularly the *Alcidæ*, which lay a single large egg, sit for a lengthened period—30 to 33 days in the case of the Common Guillemot and Razorbill, and even more in the case of the Puffin, unless the egg hatched in my incubator took an abnormally long time.

I have only seen two statements regarding the period among the *Impennes*, namely, Sir Wyville Thomson's, that the Tufted Penguin takes about 6 weeks; and that of Prof. Studer, which Dr. Gadow looks upon as an under-estimate.

A solitary instance exhausts my information concerning the *Crypturi*. According to Mr. Bartlett, the Rufous Tinamou hatched its eggs in the Zoological Society's Gardens in 21 days, which is about the same time as the typical *Gallinæ* take.

The *Casuarii* are a very long-period race, longer relatively than the *Struthiones*—the Emu, for instance, requiring about 2 months' incubation, the Rhea taking from 1 to 2 weeks less; but the time seems very elastic in these two Orders. It would appear that by artificial incubation Ostrich eggs may be hatched in from 40 to 45 days, whereas in the natural state they take from 55 to 60 days.

Unfortunately I am unable to cite a reliable record of the period of incubation among the *Apteryges*. That it is of long duration may be inferred from the fact that an Apteryx in the Zoological Gardens, London, sat on an egg the unprecedented time of within a few days of 4 months, the egg, however, proving unfertile (Bartlett, P. Z. S. 1868, p. 329).

To sum up: while in a broad sense it may be said that the larger the egg the longer the period of incubation, it is evident that such a rule cannot be applied with any certainty unless the eggs compared belong to birds possessing a considerable amount of affinity. Consequently, before we venture to predict of any two eggs, not very dissimilar in size, that the one will have a shorter period than the other, we must take into consideration the Order, or perhaps even the Family, to which each belongs, as well as their relative size. If size alone were relied on, we should conclude, for instance, that a Partridge's egg would hatch in less time than

a Raven's, instead of taking about four days longer; and that a Long-eared Owl's would take almost exactly the same time as a Ring Dove's, instead of half as long again.

Tiedemann, after remarking that "the duration of incubation differs much," makes the following statement:—"In general one finds that it is in proportion to the degree of development which the embryo reaches in the egg, so that birds whose embryo leaves the egg little developed and formed, incubate a shorter time than those whose embryo is hatched much developed. To those whose embryo leaves the egg little developed belong the Birds of Prey, the *Passeres* (Singvögel), and the *Picariæ* (Klettervögel)." The inclusion of the Birds of Prey in the group is unfortunate for the theory, for instead of having a short period of incubation, as Tiedemann supposed, they undoubtedly have a long one. The rule, no doubt, applies in many cases, but clearly not in all, for the Diurnal Birds of Prey, the Owls, and the Gannets, for example, all incubate for more or less protracted periods, yet their young are particularly helpless when hatched.

In conclusion, I must acknowledge the great obligations I am under to many friends (too numerous to particularize here) for invaluable assistance rendered in a variety of ways. To one and all I now return my sincerest thanks.

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* Morris seems to have taken his data from Meyer, who again probably followed Naumann.

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XI.—On the *Fijian Species of the Genus Pachycephala*.

By HENRY SEEBOHM.

THE acquisition of the Layard Collection of Polynesian Birds, which I have been studying for the last few months, enables me to correct some of the inaccuracies and to supply some of the deficiencies which appear in the Catalogue of the Shrikes in the National Collection (Gadow, Cat. Birds Brit. Mus. viii. pp. 185-226).

I propose to confine myself in the present paper to the species of the genus *Pachycephala* which inhabit the Fiji Islands. My friend Dr. Gadow reduces them to three species; but it seems to me that he ought to have recognized six species, with a possible seventh, which neither of us has seen. This mysterious species has been named *Pachycephala intermedia* (Layard, Ibis, 1876, p. 154). It is said to come from the north-east coast of Viti Levu, to have light yellow underparts, with a perfect though narrow black ring round the neck. It may be rash to express an opinion without having seen an example of this bird, but I am inclined to agree with Dr. Gadow that the description may refer to an abraded and faded example of *P. torquata*, a species only known from Taviumi. The narrow pectoral band is characteristic of *P. kandavensis*; but this species has a white throat, and is only known from Kandavu, so that the hypothesis that the types (which cannot be found) might have been stained examples of that species, is scarcely so tenable as that suggested by Dr. Gadow. *A priori* it must be admitted that it would be very remarkable for two such closely allied species as *P. graeffi* and *P. intermedia* to be both found on the same